"A Comprehensive Study of IoT Applications for Energy management in different sectors of rural areas in western Uttar Pradesh"

A Synopsis submitted for the registration

DOCTOR OF PHILOSOPHY

In

Computer Science and Application

By

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(July 2021)

1. Introduction

1.1 Energy Management

Our planet is already in a constant state of change as a result of growing energy needs. Each home, industry, agriculture, and so on, energy is essential. According to current statistics, global energy consumption is predicted to rise by 48% by 2040, according to a research issued by the US Energy Information Administration (EIA). It is critical to properly manage energy and intelligently conserve it. Energy management is currently a subject of considerable importance and scope. It entails selecting from a range of energy-producing sources that will provide energy to a variety of sectors with minimizing losses and expenses. The sources and loads are heterogeneous, dispersed and the reaction of the system, the choice of sources, must be done in real-time to avoid power failure. [1] According to Verein Deutscher Ingenieure (VDI), "Energy management is the proactive, organized, and systematic coordination of procurement, conversion, distribution, and use of energy to meet the requirements, taking into account environmental and economic objectives."

The need for energy management in rural regions has also changed in recent years. Energy management in rural areas is a difficult problem for sustainable agriculture and other different types of tasks to solve. Due to poor treatment of animal and broiler wastes, a huge number of livestock farms, including dairy and poultry farms, are the leading source of pollution in the environment. The proper disposal of trash not only decreases pollution but also provides an extra source of power. Using multiobjective optimization, an effective energy management model is created. To assure an uninterrupted supply of energy while also minimizing environmental consequences and the cost of power to customers [2]. The planned concept calls for power to be generated using biogas. as pattern of its use. As a result, there is a pressing need to re-manage the entire system using new technologies. One of the most important tasks in the field of rural energy systems is the development of sustainable energy infrastructure, which is a well-organized eco- and societal-friendly technical system that not only transmits energy from producer to consumer, but also meets all environmental and technical requirements

With rising power requirement and emerging technologies focusing on obtaining the most and least expensive energy feasible, the use and release of Energy Management Systems (EMS) is

expanding among end users and utilities alike. Utilities frequently install EMS capable of reducing or even balancing the costs of fixed capacity for demand growth or renewables integration, for example. End users, on the other hand, want to be able to track real-time costs at their homes, SOHOs, buildings, and facilities, as well as different industries [3]. Six percent of the world's primary energy consumption is consumed by India. Rapid urbanization and population expansion have had a significant influence on energy consumption and carbon emissions. Cities are challenged with a varied set of issues that are interconnected (building environment, mobility, water and waste management and public services). For sustainable and low-carbon urban development, it is important to re-examine these problems by using smart energy management (SEM) concepts. Furthermore, one of the most difficult tasks for cities is to manage their energy footprint, and as current cities grow and transition into smart cities, SEM becomes an important element of the urban transformation [4].

1.2 Internet of Things

The Internet of Things (IoT) is a new way of doing things that is quickly growing rapidly in today's wireless telecommunications environment. The main idea behind this notion is that there are a variety of things or objects everywhere around us - such as RFID tags, sensors, actuators, mobile phones, and so on. Internet of Things (IoT) allows electrical things and sensors to communicate with each other through the internet. The most noticeable consequences of the IoT implementation will be visible in both the working and domestic domains from the perspective of a private user. Demotics, assisted living, e-health, and improved learning are only a few examples of potential application scenarios where the new paradigm will play a key role in the near future. Similarly, the most obvious effects will be equally clear from the standpoint of business users in sectors like as automation and industrial production, logistics, business/process management, and intelligent transportation of people and commodities [5]. Smart devices and the internet are used by IoT to give creative solutions to a variety of difficulties and concerns faced by businesses, governments, and public/private enterprises all over the world. IoT is becoming an increasingly essential part of our lives, and it can be felt all around us. IoT is a technology that brings together a wide range of smart systems, frameworks, intelligent devices, and sensors [6].

In the Internet world, the Internet of Things (IoT) is the essential future. As a result, security services like as privacy and authentication are critical for today's technology to realize IoT benefits. Furthermore, the Internet of Things provides a good potential for economic growth and a more pleasant existence. However, it poses serious security issues, particularly when these devices are hacked or become exposed to cyber-attacks. As a result, a broad and rapid IoT implementation necessitates the adoption of appropriate security and authentication mechanisms [7].

1.3 IoT and Energy Management

The invention of machine-to-machine communication, where devices can be connected wirelessly, resulting in the Internet of Things, we've developed an IoT-based Smart Energy Management system where, for example, appliances such as fans and bulbs can be controlled wirelessly based on humidity and light intensity information. Instead of just switching on and off, these inputs are used to intelligently operate the appliances. Furthermore, the system maintains track of the day-to-day power usage of the appliances, providing the user with information on how much power is utilized over time. In the Cloud server, these details are updated.

IoT Energy Management is a planning and management procedure for energy consumption trends in multiple areas. The Internet of Things Energy Management system is meant to track and improve energy compliance, resulting in greater capacity utilization, increased company productivity, lower maintenance and manpower costs, and increased energy asset dependability.

The Internet of Things (IoT) plays a key role in sustainable development in this context. This technology allows for real-time energy usage data sensing, monitoring, and collection. Real-time data makes it possible to minimize energy usage in a variety of ways. Furthermore, for effective and sustainable energy management, the energy industry is presently linked with Information and Communication Technology (ICT) technologies, such as the Internet of Things (IoT). This study looks at the significance of IoT technology in current and future energy systems from two perspectives: residential and agricultural energy needs.

2. Problem Statement

Demand and supply of energy in rural regions of Western Utter Pradesh has changed in recent years, as has the pattern of its use in different sectors. Different types of sources of energy are available in the rural areas but due to lack of technological implementation they all are not manage properly. As a result, there is a pressing need to re-manage the entire system using new technologies. One of the most important tasks in the field of rural energy systems is the development of sustainable energy infrastructure, which is a well-organized eco- and societal-friendly technical system that not only transmits energy from producer to consumer, but also meets all environmental and technical requirements.

3. Objective

The centralized objective of this research is to find out how IoT applications can help in the development of energy management systems in rural areas of western Uttar Pradesh that meet their needs and demands. Which can be accomplished by taking the following small objectives.

- Interconnect all the Resource of Energy available in the area using IoT applications.
- How IoT applications can minimize the faults.
- How IoT applications can manage demand and supply of Energy.
- How IoT applications manage the need of energy for rural residential in routine life.
- How IoT applications help for reduce the greenhouse gases and save the environment.
- How IoT applications help in efficient use of energy in rural industries.

4. Scope of Study and Hypotheses

In rural regions of western Utter Pradesh, the trend of employing various energy technologies is changing and peoples are moving from traditional energy systems to other available options. As a result, there is a huge opportunity to find how IoT technology can assist in managing this whole energy management system like generation, distribution and consumption system, minimizing energy loss, minimizing equipment failure, and eventually forecasting the entire requirement for energy from various sources.

Energy efficiency refers to a system that uses less energy and is more efficient, resulting in a system that is healthier and more dependable. IoT can play a significant role in decreasing losses and cutting carbon emissions in the operation and maintenance (O&M) of energy obtaining assets and in the transmission and distribution (T&D) of energy end use. This IoT-based energy management system can monitor and control real-time energy usage while also increasing energy performance.

5. Literature review

After review of different literatures now days in the energy management using IoT there is a big need for the implementation of new technologies.

1. **Intelligent Energy Management System, M. Cirrincione1, M. Cossentino2, S. Gaglio2,3, V. Hilaire1, A. Koukam1, M. Pucci4, L. Sabatucci3, G. Vitale4, Conference Paper · July 2009**

   Energy management is a topic that has grown in importance and complexity in recent years. It entails selecting among a collection of energy-producing sources that will provide energy to a set of loads while minimising losses and expenses. Because the sources and loads are heterogeneous and distributed, the system's reaction, or source selection, must be done in real time to avoid a power outage. The purpose of this work is to describe a system that can self-regulate a heterogeneous set of power sources and loads organised as a coherent group of entities, referred to as a microgrid, in order to optimise numerous criteria, including cost and efficiency.

2. **“Economically efficient and environment friendly energy management in rural area”, Muhammad Naveed Naz,1 Muhammad Naeem,1,2 Muhammad Iqbal,1and Muhammad Imran3**

   Energy management in rural areas is a difficult problem for sustainable agriculture to solve. Due to poor treatment of animal and broiler wastes, a huge number of livestock farms, including dairy and poultry farms, are the leading source of pollution in the environment. The proper disposal of trash not only decreases pollution but also provides an extra source of power. Using multiobjective optimization, an effective energy management model can

be created to assure an uninterrupted supply of energy while also minimizing environmental consequences and the cost of power to customers.

3. **Energy Management Systems, J. Amaral, Cecília Reis, R. F. Mesquita Brandão, 2013 48th International Universities' Power Engineering Conference**

   With growing electricity demand and newer technologies focusing on obtaining the most and cheapest energy feasible, the use and release of Energy Management Systems (EMS) is expanding among end users and utilities alike. Utilities frequently use EMS capable of reducing or even levelling fixed capacity costs for demand growth or renewables integration, for example. End users, on the other hand, want to be able to track real-time costs in their homes, buildings, and facilities, as well as large corporations.

4. **Smart Energy Management Policy in India—A Review, Komali Yenneti [1], Riya Rahiman [2] , Adishree Panda [2] and Gloria Pignatta [1], 21 August 2019**

   India consumes 6% of the world's primary energy. Rapid urbanisation and population increase have had a significant impact on energy consumption and CO2 emissions. Cities, in particular, face a complex and interconnected set of issues in a variety of areas (building environment, mobility, water and waste management and public services). For sustainable and low-carbon urban development, it is necessary to re-examine these issues by incorporating smart energy management (SEM) concepts. Furthermore, maintaining a city's energy footprint is one of the most difficult goals, and as existing cities expand and transition into smart cities, SEM becomes more important.

5. **The Internet of Things: A Survey, Luigi Atzori[1], Antonio Iera[2], Giacomo Morabito[3], Computer Networks Journal, Volume 54, Issue 15, 28 October 2010**

   The integration of multiple technologies and communications systems is the main enabler of this promising paradigm. The most important technologies are identification and tracking, wired and wireless sensor and actuator networks, better communication protocols (shared with the Next Generation Internet), and distributed intelligence for

smart things. Any significant contribution to the advancement of the Internet of Things, as one could expect, must inevitably be the product of synergetic activity in several domains of knowledge, such as telecommunications, informatics, electronics, and social science.

6. **Internet of Things is a revolutionary approach for future technology enhancement: a review Sachin Kumar1*, Prayag Tiwari2 and Mikhail Zymbler1, Journal of Big Data (2019)**

   The Internet of Things (IoT) is a new paradigm that has transformed traditional lifestyles into high-tech ones. Smart cities, smart homes, pollution management, energy conservation, smart transportation, and smart industries are examples of IoT-driven developments. Many important research studies and investigations have been conducted in order to improve technology via IoT. However, in order to realise the full potential of IoT, a number of obstacles and issues must be addressed. These difficulties and challenges must be evaluated from a variety of perspectives, including applications, challenges, enabling technologies, social and environmental consequences, and so on.

7. **Security Challenges and Limitations in IoT Environments, Suha Ibrahim Al-Sharekh$_1$, Khalil H. A. Al-Shqeerat$_2$, International Journal of Computer Science and Network Security, VOL.19 No.2, February 2019**

   For modern technologies to achieve the benefits of IoT services, security services such as privacy and authentication are critical. Furthermore, the Internet of Things provides a fantastic chance for economic growth and a more pleasant life. However, it poses serious security issues, particularly when these devices are hacked or become subject to cyber-attacks. As a result, a broad and rapid IoT deployment necessitates the adoption of appropriate security and authentication solutions.

8. **IoT security: challenges and countermeasures, Mohamed Litoussia, Nabil Kannoufb, Khalid El Makkaouic,a, Abdellah Ezzatia, The 7th International Symposium on Emerging Information, Communication and Networks (EICN 2020)**

The Internet of Things (IoT) intends to improve people's quality of life. Nevertheless, IoT is subject to a variety of assaults, necessitating the use of difficult procedures to ensure its security. The primary goal of IoT security is to safeguard consumer privacy, data integrity and confidentiality, the security of infrastructures and IoT devices, and the availability of services supplied by an IoT ecosystem. We describe the IoT security issues and remedies in this paper.

9. **"Analysis of Energy Management by Using IOT ",Manmay Banerjee, Amandeep Dhiman, Prateek Shrivastava, Asst. Prof. Rehana Parveen , International Journal of Scientific Research & Engineering Trends Volume 7, Issue 2, March-April-2021,**

   The key to energy consumption and waste is demand predictability, which allows us to make substantial savings. Only "IOT" allows for totally autonomous energy plants and industry automation. By utilizing smart sensors, we can monitor system performance in real time, and by using an IoT-based machine learning interface, we can reduce the amount of equipment and manpower required.

10. **"The Role of the Internet of Things (IoT) in Energy Management of a Smart City", I Maltseva1, K Tkachuk2, 2020 *IOP Conf.***

    One of the most important tasks in the field of energy management systems is the development of sustainable energy infrastructure, which is a well-organized eco- and societal-friendly technical system that not only transmits energy from producer to consumer, but also meets all environmental and technical requirements. Energy sectors are currently integrated with Information and Communication Technology (ICT) solutions, especially the Internet of Things (IoT), for efficient and sustainable energy management.

11. **"Internet of Things (IoT) and the Energy Sector ", Naser Hossein Motlagh 1 , Mahsa Mohammadrezaei 2 and Julian Hunt 3 and Behnam Zakeri 3,4,*, Energies 2020**,

    Integration of renewable energy and energy efficiency are critical facilitators of sustainable energy transitions and climate change mitigation. Modern technologies, such as the Internet of Things (IoT), may be used in a variety of ways in the energy industry, including energy production, transmission and distribution, and consumption. The

Internet of Things may be used to improve energy efficiency, increase the efficient use of energy, and reduce the environmental effect of energy use.

12. **IoT Based Smart Energy Management System, Vignesh Mani, Abhilasha, Gunasekhar, Lavanya and Suresh Sankaranarayanan, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 16 (2017)**
With the invention of machine-to-machine communication, where devices can be connected wirelessly, resulting in the Internet of Things, we've created an IoT-based Smart Energy Management system where appliances, such as fans and bulbs, can be controlled wirelessly based on humidity and light intensity data. These inputs are utilized to intelligently operate the appliances rather than just turning them on and off. In addition, the system maintains track of the day-to-day power usage of the appliances, providing the user with information on how much power is utilized over time. These information is updated on the Cloud server. Every family has been able to save energy with this prototype system that was designed.

13. **The Role of the Internet of Things (IoT) in Energy Management of a Smart City, I Maltseva1, K Tkachuk2, SPCECI 2019**
Three main objectives for Europe are included in the 2030 climate and energy framework: to reduce CO2 emissions by half by 2030, and to reduce CO2 emissions by half by 2050.Raise the percentage of renewable energy (RE) sources and reduce greenhouse gas (GHG) emissions encourage energy conservation These tasks are also significant to Russia. As a member of the Germany, one of the main players, has increased its renewable energy target to 65 percent by 2030. Globalization is happening at the same time. By 2040, energy demands are anticipated to rise by 30%. Energy systems should be considered in this perspective. Not only be planned for present supply, but also for a significant rise in demand for energy. The main aim is to move away from centralized to decentralized energy systems in order to achieve these goals and prevent an energy crisis. Furthermore, for effective and sustainable energy management, energy sectors are presently connected with Information and Communication Technology (ICT) technologies, particularly the Internet of Things (IoT).

14. **Internet of Things is a revolutionary approach for future technology enhancement: a review, Sachin Kumar1* , Prayag Tiwari2 and Mikhail Zymbler1,Journal Big Data (2019)**

The Internet of Things (IoT) is a new paradigm that has transformed traditional lifestyles into high-tech ones. Smart cities, smart homes, pollution management, energy conservation, smart transportation, and smart industries are examples of IoT-driven changes. Many important research studies and investigations have been conducted in order to improve technology via IoT. However, in order to realize the full potential of IoT, a number of problems and concerns must be solved. These concerns and challenges must be examined from a variety of perspectives, including applications, challenges, enabling technologies, social and environmental consequences, and so on. The primary objective of this review article is to give a thorough examination from both a technological and a social point of view. The essay goes through many IoT difficulties and issues, as well as architecture and key application domains. In addition, the essay highlights current literature and shows how it contributes to various areas of IoT. Similarly, the significance of big data and its analysis in relation to IoT was discussed.

15. **Analysis of Green IoT, Nitasha Khan[1,2], Aznida Abu Bakar Sajak[3], Muhammad Alam[4,5], M.S Mazliham[1], RETREAT 2020,**

The Internet of Things (IoT) is a concept and hypothesis that involves linking billions of objects and allowing them to share huge amounts of data. Green IoT shows IoT theory with increased energy efficiency. Initially, an overview of Green IoT was presented, as well as the problems that were encountered as a result of the excessive use of energy-hungry IoT devices. This article covered a lot of ground when it came to energy efficiency in the Internet of Things. The authors discussed various green IoT problems, existing work, possibilities, and future directions.

6. Methodology or work plan

This research will go through of different article analysis. From which different methods will identified for Internet of Things(IoT) application for different areas of applications which will help for manage the energy management. This research will complete in these different phases.

Phase 1: - Literature Review

Phase 2: - Study of available tools, mechanisms, categorizing issues and challenges, evaluating the gaps of existing systems and identifying the different sources of energy. Find the techniques for improvisation the whole system using IoT applications.

Phase 3 Formulating the research objectives- The Problem statement

Phase 4 Retrieve all possible solutions from previous research for the given objective on the basis of IoT applications.

Phase 5 Prepare different IoT methods for manage all aspects of energy based on research work.

Phase 6 Final report writing, reviewing of thesis and submission

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3. Energy Management Systems, J. Amaral, Cecília Reis, R. F. Mesquita Brandão, 2013 48th International Universities' Power Engineering Conference

4. Smart Energy Management Policy in India—A Review, Komali Yenneti [1], Riya Rahiman [2], Adishree Panda [2] and Gloria Pignatta [1], 21 August 2019

5. The Internet of Things: A Survey, Luigi Atzori[1], Antonio Iera[2], Giacomo Morabito[3], Computer Networks Journal, Volume 54, Issue 15, 28 October 2010

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9. Economically efficient and environment friendly energy management in rural area, Muhammad Naveed Naz, Muhammad Naeem, Muhammad Iqbal, and Muhammad Imran

10. "Energy Management Strategy for Rural Communities'DC Micro Grid Power System Structure with Maximum Penetration of Renewable Energy Sources"Maheswaran Gunasekaran 1, Hidayathullah Mohamed Ismail 1, Bharatiraja Chokkalingam 1,Lucian Mihet-Popa 2,* and Sanjeevikumar Padmanaban 3

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